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<b>13. SUPPLEMENTARY NOTES</b>					
<b>14. ABSTRACT</b>  The key deliverable in this award's statement of work is to "Develop a new program at Washington State University - the Spokane Sleep Research Initiative - to focus on the effects of sleep and sleep loss on human performance." As the Spokane Sleep Research Initiative grew, it was renamed the Sleep and Performance Research Center (SPRC). Major findings published during the interval covered by this addendum (05/01/2009-04/30/2010) were: 1) Working shifts and extended work hours (that cut into total sleep time in 24 hours) are tied to long term adverse health outcomes; 2) Mathematical models predicting performance from sleep wake history are becoming increasingly accurate and are capable of being individualized to take into account individual differences in tolerance to sleep loss; 3) The theory that whole animal sleep begins with local use dependent sleep is gaining support. During the interval covered by this addendum (05/01/2009-04/30/2010), the Sleep and Performance Research Center 11 core faculty members have produced 52 publications (see References).					
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## **Introduction**

The Sleep and Performance Research Center (SPRC) conducts human and animal studies in laboratory and field settings in support of basic and applied sleep research at Washington State University (WSU). The SPRC focuses on understanding the brain organization of sleep in humans and animals and on using this understanding to link sleep, by way of the underlying neurobiology, to key indicators of performance, be they physiological, behavioral or cognitive. The research contributes to sustaining human productivity, safety, health, and well-being and may contribute to the understanding of the neurobiology of consciousness.

The SPRC core faculty members are:

Gregory Belenky, M.D., Research Professor, VCAPP, WSU Spokane (SPRC Director)

Christopher Davis, Ph.D., Assistant Research Professor, WWAMI, WSU Spokane

Lois James, Ph.D., Assistant Research Professor, Criminal Justice and Criminology, WSU Spokane

Levente Kapás, M.D., Ph.D., Associate Professor, VCAPP, WWAMI, WSU Spokane

Ilia Karatsoreos, Ph.D., Assistant Professor, VCAPP, WSU Pullman

James Krueger, Ph.D., Regents Professor, VCAPP, WWAMI, WSU Spokane

Jaak Panksepp, Ph.D., Professor, VCAPP, WSU Pullman

David Rector, Ph.D., Professor, VCAPP, WSU Pullman (left WSU in 2011)

Éva Szentirmai, M.D., Ph.D., Assistant Professor, VCAPP, WWAMI, WSU Spokane

Hans Van Dongen, Ph.D., Research Professor, VCAPP, WSU Spokane (SPRC Assistant Director)

Bryan Vila, Ph.D., Professor, Criminal Justice and Criminology, WSU Spokane

Jonathan Wisor, Ph.D., Associate Professor, VCAPP, WWAMI, WSU Spokane

The current eleven SPRC core faculty members are all involved in sleep research and their productivity is evidenced by their collective publications and extramural funding. SPRC core faculty members are internationally renowned for their scientific contributions, which have led to paradigm shifts in science and policy changes at the state and national levels.

## **Program of Research**

### **Field Studies in Humans**

Slaven et al. (2009) applied performance prediction modeling to performance in the operational environment.

Violanti et al. (2009) analyzed the effects of atypical work hours (e.g., extended work hours and shiftwork) on the incidence of metabolic syndrome in serving police officers. They observed a positive correlation.

### **Laboratory Studies in Humans**

Goel et al. (2009) characterized the circadian rhythm profiles in women with night eating disorder.

McCauley et al. (2009) developed a new mathematical performance prediction model to predict the effects of sleep loss on performance.

Ratcliff and Van Dongen (2009) applied diffusion modeling to demonstrate that sleep loss affects a number of different cognitive processes.

Smith et al. (2009) applied Bayesian modeling in a multi-dimensional parameter space to adapt a performance prediction model to predict the performance of a specific individual during sleep loss.

### **Laboratory Studies in Animals**

Hara et al. (2009) demonstrated that thyrotropin releasing hormone increased behavioral arousal by modulation orexin/hypocretin neurons; May et al. (2009) demonstrated that interleukin 6 (IL-6) administration increases rapid eye movement (REM) sleep; Peterfi et al. (2009) found that the anterolateral projections of the medial basal hypothalamus affect sleep; Rector, Schei, and Rojas (2009) in a study of the mechanisms underlying local sleep described sleep/wake state dependent changes in cortical surface electrical responses; Rector et al. (2009) correlated rapid light scattering with neurophysiological activity; Schei and Rector (2009) demonstrated local sleep/wake dependent in auditory hemodynamic responses using implanted photo diodes; Szentirmai et al. (2009) demonstrated that the preproghrelin gene is required for normal thermoregulation in rats and mice; Topchiy et al. (2009) correlated conditioned lick behavior with evoked responses induced by single whisker twitches; Winniger, Schei, and Rector (2009) demonstrated a complete optical for both stimulating and recording from animal cortex; and Wisor et al. (2009) compared the effects of Ramelteon and triazolam in mice with genetically-induced early morning awakening.

## **Reviews**

Gunzelman et al. (2009) reviewed the known correlates of deficits in sustained attention especially as pertaining to sleep loss. Karatsoreos and McEwen (2009) reviewed the role of circadian disruption in depression. King, Belenky, and Van Dongen (2009) reviewed the determinants of resistance and sensitivity to sleep loss. Krueger, Churchill, and Rector (2009) reviewed the effects of cytokines and other neuromodulators on sleep and sleep states. Krueger, Churchill, and Rector (2009) reviewed sleep state modulation and cytokines. Krueger, Leyva-Grado, and Bohnet (2009) reviewed cytokines, host defense, and sleep. Krueger and Majde (2009) reviewed immunity and sleep. Krueger, Szentirmai, and Kapas (2009) reviewed the biochemistry of sleep function. Rector et al. (2009) reviewed the physiological markers of local sleep. Van Dongen and Belenky (2009) reviewed individual differences in sensitivity to sleep loss in the industrial/operational environment.

### **Key Research Accomplishments**

- Extended work hours and night shift worked are correlated with the metabolic syndrome in police officers
- Performance prediction modeling works in the operational environment as well as under laboratory conditions.
- A variety of approaches (differential equations, diffusion modeling, and Bayesian statistics improve the fidelity of the predictions of the effects of sleep loss on performance.
- The cytokine IL-6 stimulates REM Sleep
- The theory of local sleep gained support from studies showing local sleep states associated with increased activity in the same regions prior to local sleep onset

### **Reportable Outcomes**

- Working shifts and extended work hours (that cut into total sleep time in 24 hours) are tied to long term adverse health outcomes
- Mathematical models predicting performance from sleep wake history are becoming increasingly accurate and are capable of being individualized to take into account individual differences in tolerance to sleep loss
- The theory that whole animal sleep begins with local use dependent sleep is gaining support

### **Conclusions**

Sleep, sleep loss, and performance are active areas of research with progress being made through field studies of humans, laboratory studies of humans and animals, field and laboratory studies of humans, and scholarly review of the existing scientific literature.

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